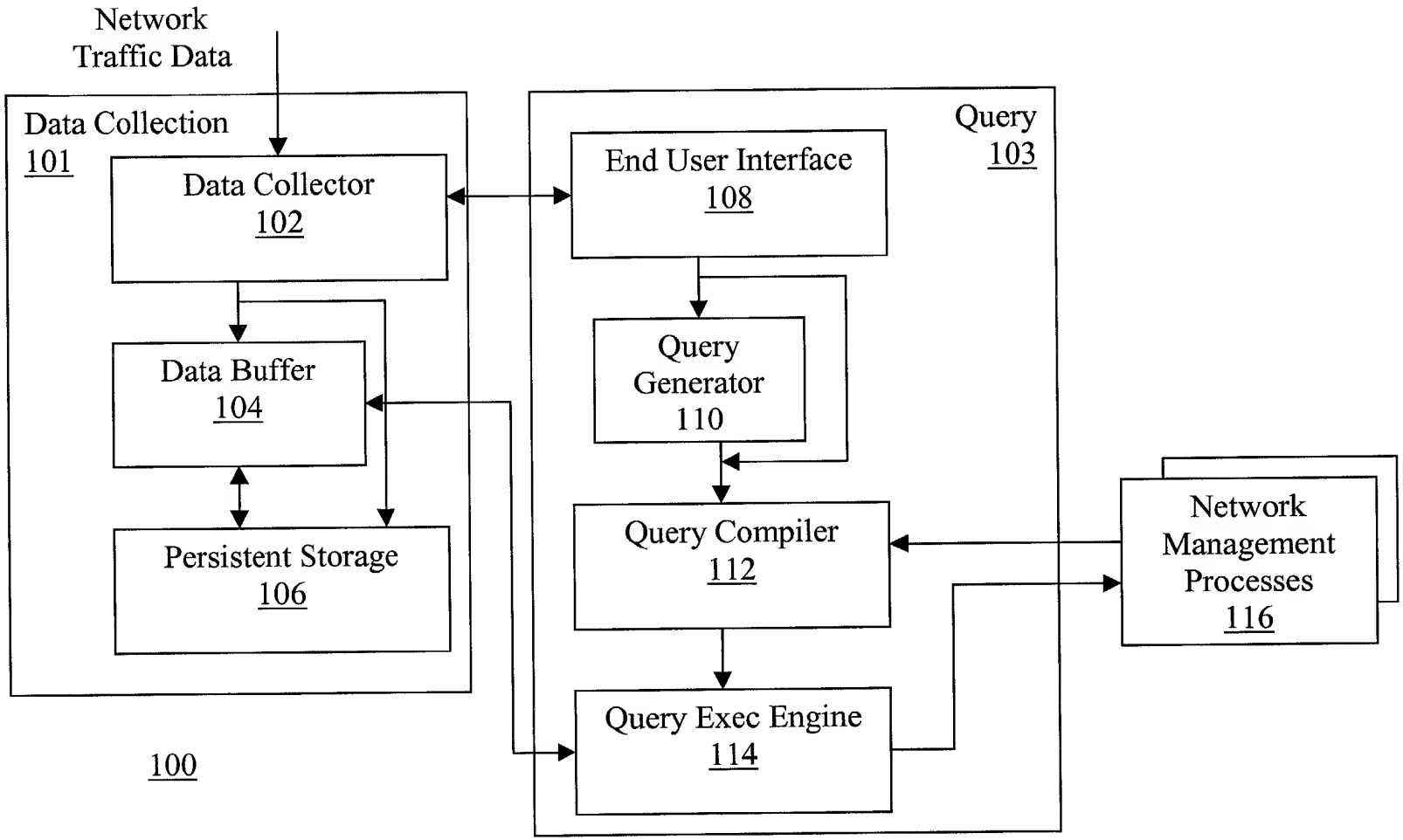


Figure 1

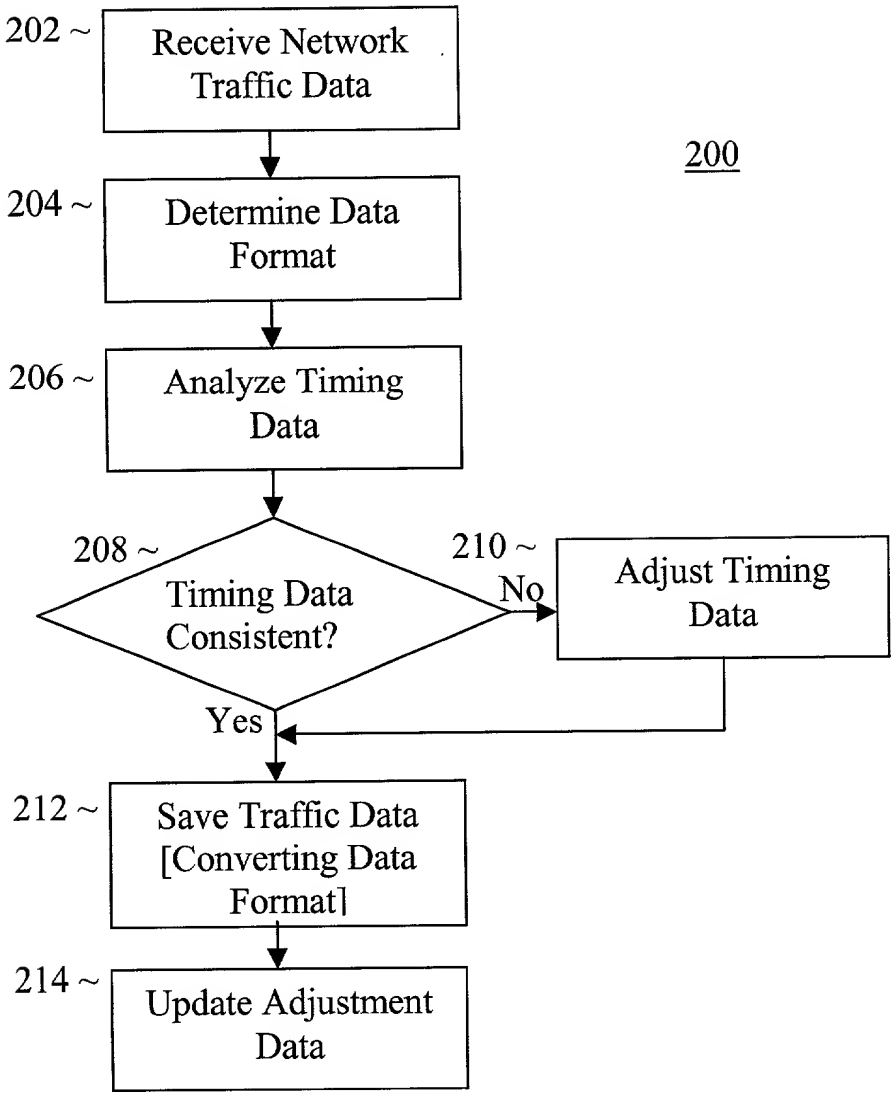

202 ~
Receive Network Traffic Data
200
204 ~
Determine Data Format
206 ~
Analyze Timing Data
208 ~
Timing Data Consistent?
210 ~
No
Adjust Timing Data
Yes
212 ~
Save Traffic Data [Converting Data Format]
214 ~
Update Adjustment Data

Figure 2

Header (32 bytes):

302

Original flow data type	Number of entries
Router uptime (ms)	
Unixsecs on router	
Unixsecs on sensor	
Flow sequence counter	
Engine type	Engine ID	Unix millisecs on router
Agg method	Agg version	Sampling interval
Sender addr (in host order)	

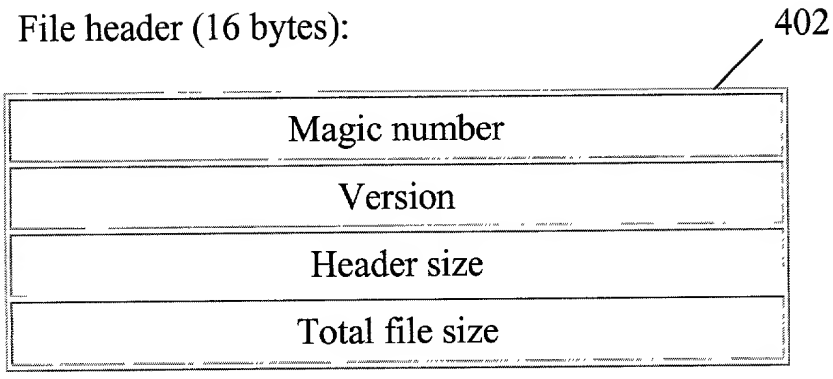
Entry (52 bytes):

304

Source addr (in host order)			
Dest addr (in host order)			
Next hop addr (in host order)			
In interface		Out interface	
Packets			
Bytes			
Flow start time			
Flow end time			
Source port		Dest port	
Padding	TCP flags	IP protocol	TOS
Source AS		Dest AS	
Src net len	Dst net len	Padding	
Flows			

Figure 3

File header (16 bytes):



Data Header (28 bytes):

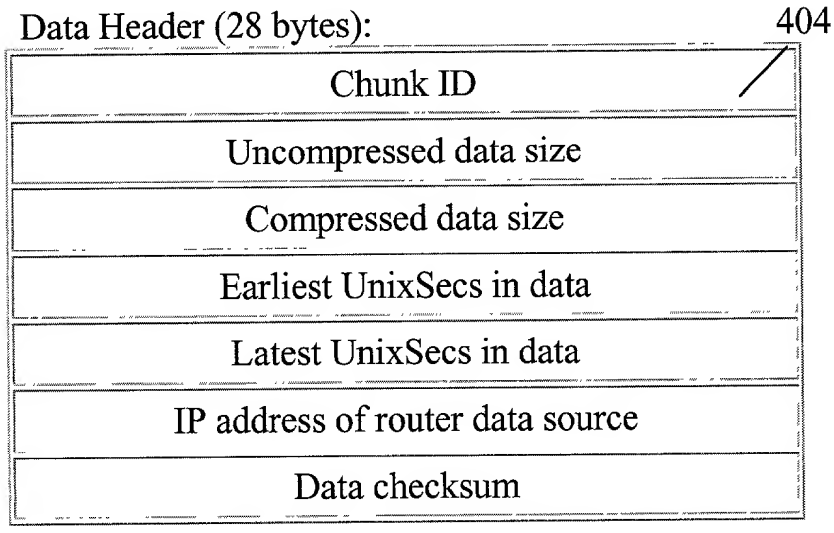


Figure 4

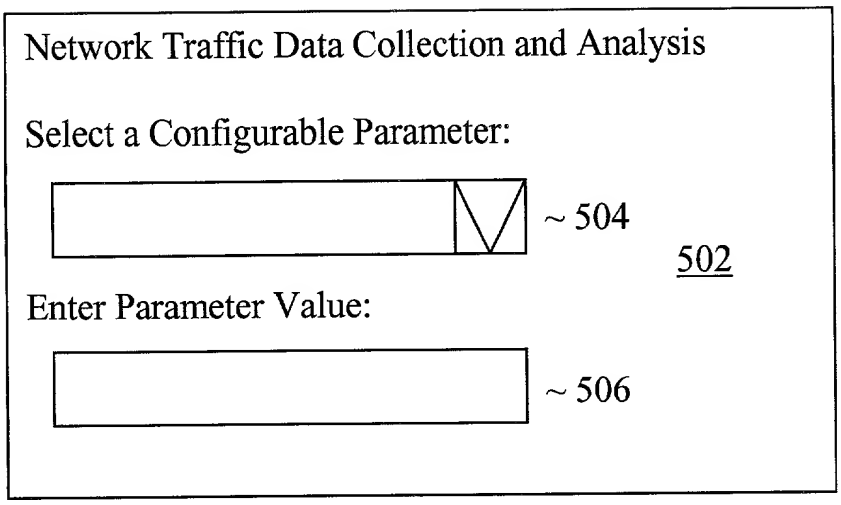


Figure 5a

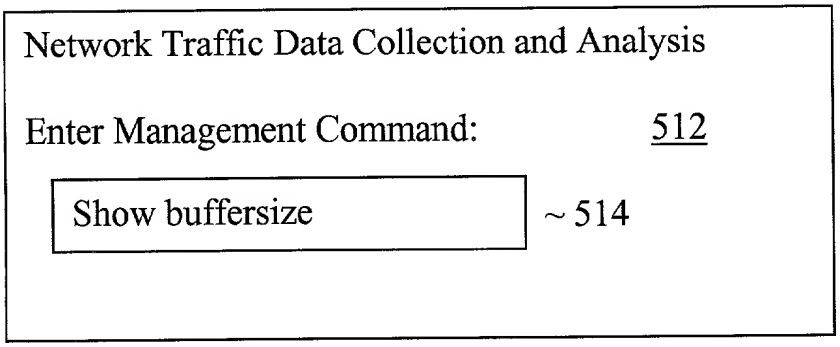


Figure 5b

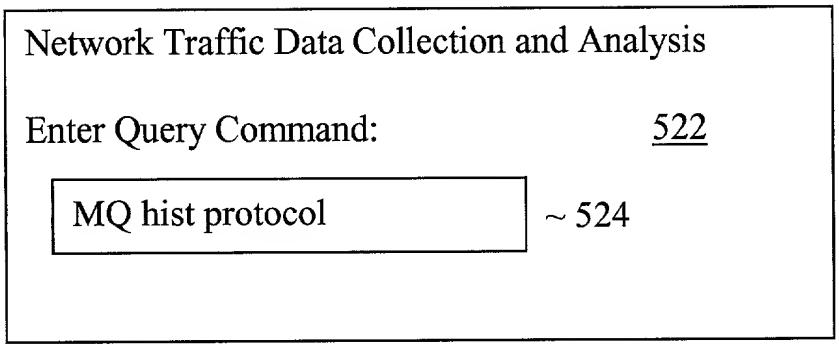


Figure 5c

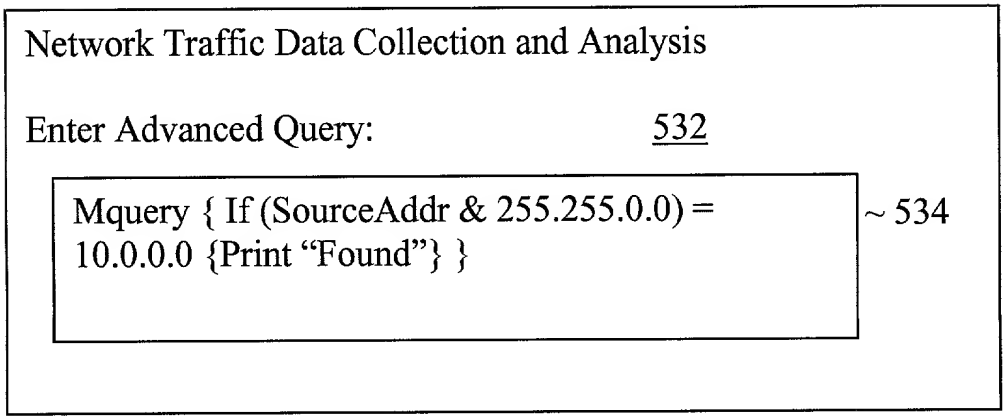


Figure 5d

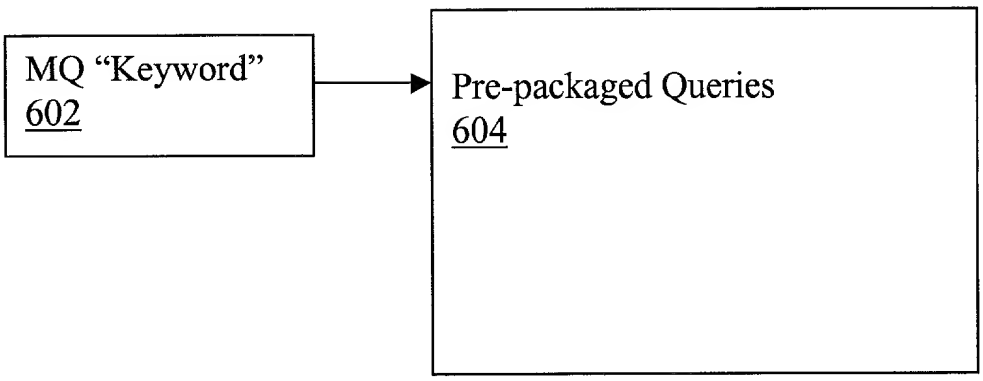


Figure 6a

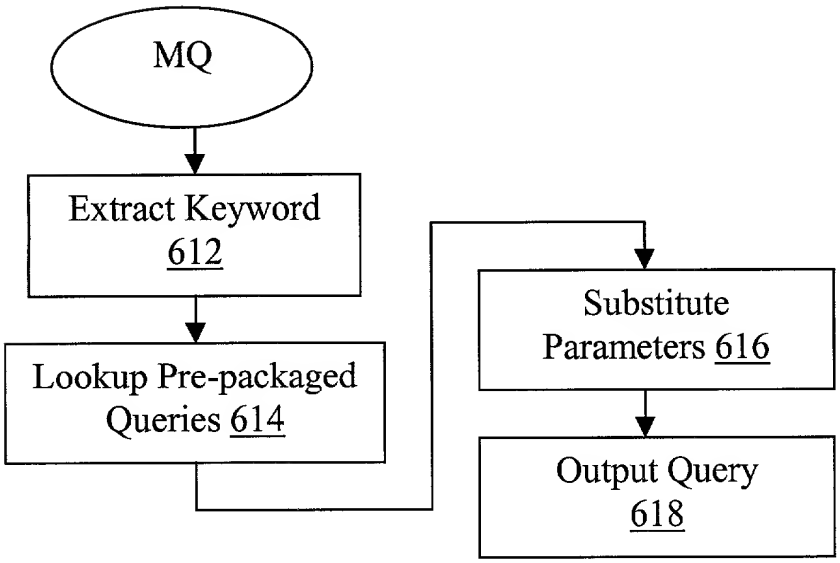


Figure 6b

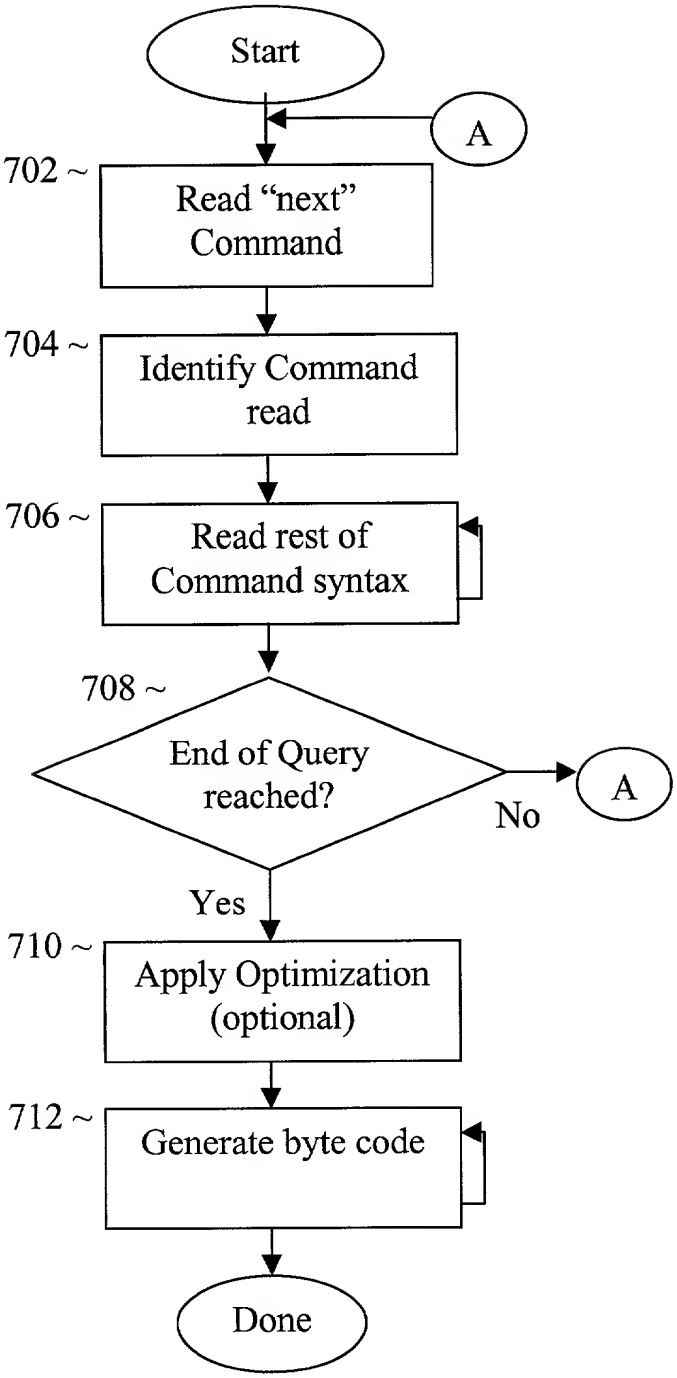

Start
A
702 ~
Read "next" Command
704 ~
Identify Command read
706 ~
Read rest of Command syntax
708 ~
End of Query reached?
No
A
Yes
710 ~
Apply Optimization (optional)
712 ~
Generate byte code
Done

Figure 7

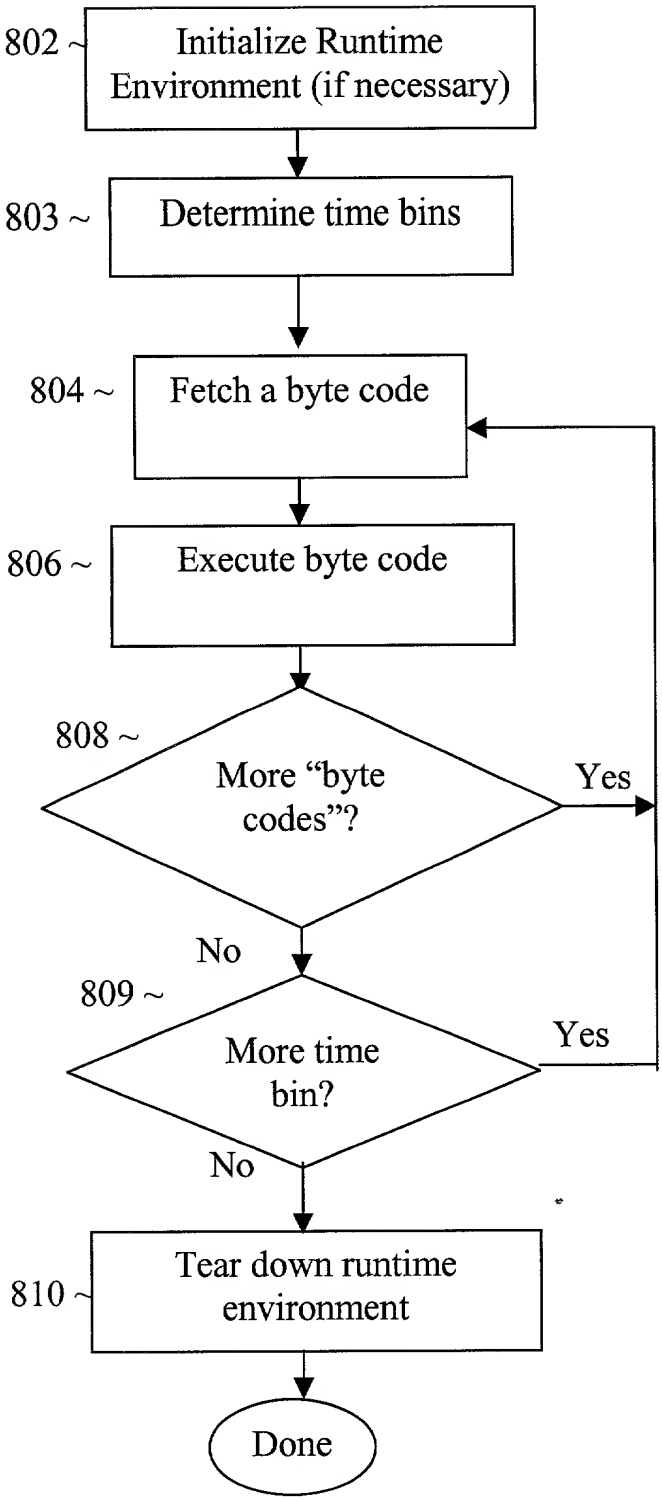

802
Initialize Runtime Environment (if necessary)
803
Determine time bins
804
Fetch a byte code
806
Execute byte code
808
More "byte codes"?
Yes
No
809
More time bin?
Yes
No
810
Tear down runtime environment
Done

Figure 8

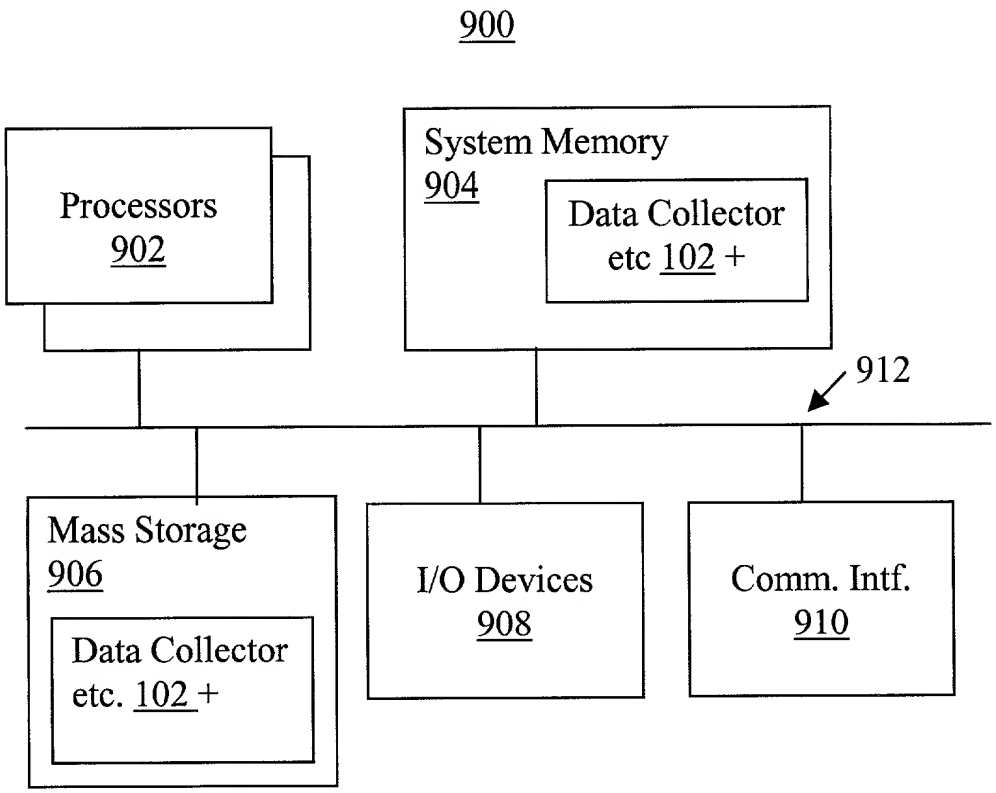


Figure 9

```
// Copyright (c) 2000-2001 Asta Networks.  All rights reserved.

#ifndef __MARIO_QUERIES_HH__
#define __MARIO_QUERIES_HH__

enum QueryVersions
{
   MARIO_MAJOR_QUERY_VERSION    = 4,
   MARIO_MINOR_QUERY_VERSION    = 2,
   MARIO_QUERY_VERSION = ((MARIO_MAJOR_QUERY_VERSION
<< 4) + MARIO_MINOR_QUERY_VERSION)
};

enum Commands
{
   CMD_PRINT_SYSTEMVALUE   = 1,
   CMD_PRINT_NUMBER        = 2,
   CMD_PRINT_STRING        = 3,
   CMD_PRINT_NEWLINE       = 4,
   CMD_PRINT_HIST          = 5,
   CMD_PRINT_HIST_KEYS     = 6,
   CMD_SET_VAR             = 7,

   CMD_IF          = 8,
   CMD_IF_ELSE     = 9,

   WITH_FIRST_PACKET    = 10,
   WITH_LAST_PACKET     = 11,

   FOR_EACH_PACKET      = 12,
   FOR_EACH_FLOW        = 13,

   CMD_DEF_HIST         = 14,
   CMD_ADD_TO_HIST      = 15,
```

Figure 10a

```
  CMD_INCR_VAR          = 17,
  CMD_INCR_VAR_BY       = 18,

  CMD_INCR_LVAR         = 19,
  CMD_INCR_LVAR_BY      = 20,
  CMD_PRINT_LVAR        = 21,

  CMD_DEF_ARRAY                 = 22,
  CMD_ADD_TO_ARRAY              = 23,
  CMD_PRINT_ARRAY               = 24,
  CMD_PRINT_ARRAY_BY_PKT        = 25,
  CMD_PRINT_ARRAY_BY_FLOW= 26
};

enum NumericValues
{
  CONSTANT_BYTE_VALUE = 0x80,
  CONSTANT_INT_VALUE  = 0x81,
  HEADER_VALUE    = 0x82,
  FLOW_VALUE      = 0x83,
  SYSTEM_VALUE    = 0x84,
  VAR_VALUE       = 0x85,
  TCPFLAGS_VALUE = 0x86
};

enum HeaderValues
{
  HV_ORIGTYPE    = 0,  // Original flow data type
  HV_COUNT       = 1,  // The number of records
  HV_ROUTERUPTIME = 2,  // Time in millisecs since router booted
  HV_ROUTERSECS  = 3,  // Seconds since 0000 UTC 1970 on router
  HV_SENSORSECS  = 4,  // Seconds since 0000 UTC 1970 on sensor
  HV_SEQNUM      = 5,  // Seq counter of total flows seen
  HV_ENGINETYPE  = 6,  // Type of interface generating the flows
  HV_ENGINEID    = 7,  // ID of interface generating the flows
  HV_ROUTERMSECS = 8,  // Unix millisecs on router
  HV_AGGMETHOD   = 9,  // Aggregation method (for NetFlow v8+)
```

Figure 10b

```
    HV_AGGVERSION   = 10, // Aggregation version (for NetFlow v8+)
    HV_SAMPINTERVAL = 11, // Sampling interval
    HV_SENDERADDR   = 12  // IP address where this data came from
};

enum FlowValues
{
    FV_SRCADDR  = 0,   // IP address of source
    FV_DSTADDR  = 1,   // IP address of destination
    FV_NEXTHOP  = 2,   // IP address of next-hop router
    FV_IN_IF    = 3,   // ID of incoming interface
    FV_OUT_IF   = 4,   // ID of outgoing interface
    FV_NUMPKTS  = 5,   // Number of packets in the flow
    FV_NUMBYTES = 6,   // Number of bytes in the flow
    FV_FIRST    = 7,   // On routerUptime scale, when flow started
    FV_LAST     = 8,   // On routerUptime scale, when flow ended
    FV_SRCPORT  = 9,   // Layer 4 source port
    FV_DSTPORT  = 10,  // Layer 4 destination port
    FV_PAD8     = 11,  // UNUSED
    FV_TCPFLAGS = 12,  // Or of all flags seen in flow, or ACK
    FV_PROTOCOL = 13,  // Layer 3 protocol
    FV_TOS      = 14,  // Type of service
    FV_SRC_AS   = 15,  // Source autonomous system
    FV_DST_AS   = 16,  // Destination autonomous system
    FV_SRC_MASK = 17,  // Number of valid src addr bits for netmask
    FV_DST_MASK = 18,  // Number of valid dst addr bits for netmask
    FV_PAD16    = 19,  // UNUSED
    FV_FLOWS    = 20   // Number of flows (when aggregated)
};

enum Operators
{
    OP_LGC_NOT      = 0xc0,
    OP_LGC_AND      = 0xc1,
    OP_LGC_OR       = 0xc2,
```

Figure 10c

```
    OP_BIT_NOT          = 0xc3,
    OP_BIT_AND          = 0xc4,
    OP_BIT_OR           = 0xc5,
    OP_BIT_XOR          = 0xc6,

    OP_EQ           = 0xc7,
    OP_NE           = 0xc8,
    OP_GT           = 0xc9,
    OP_GE           = 0xca,
    OP_LT           = 0xcb,
    OP_LE           = 0xcc,

    OP_ADD          = 0xcd,
    OP_SUB          = 0xce,
    OP_MUL          = 0xcf,
    OP_DIV          = 0xd0,
    OP_MOD          = 0xd1,
    OP_TRN          = 0xd2,

    OP_LVAR_MUL_DIV = 0xd3,

    OP_MUL_DIV_32 = 0xd4
};

enum PrintTypes
{
    PT_UINT         = 0,
    PT_INT          = 1,
    PT_IPADDR       = 2,
    PT_8BITS        = 3,
    PT_HEX          = 4,
    PT_PROTOCOL= 5,
    PT_TCPFLAGS= 6,
    PT_TM_MSECS= 7,
    PT_TM_SECS  = 8,
```

Figure 10d

```
    PT_CUINT      = 9,
    PT_CINT       = 10,
    PT_HEXBYTE    = 11,
    PT_HEXWORD    = 12,
    PT_BOOL       = 13,
    PT_SAMPINT    = 14,
    PT_HEXDWORD   = PT_HEX
};

enum HistogramValueTypes
{
    HIST_SUM      = 0x71,
    HIST_OR       = 0x72,
    HIST_MAX      = 0x73,
    HIST_MIN      = 0x74,
    HIST_FIRST    = 0x75,
    HIST_LAST     = 0x76,
    HIST_UNIQUE   = 0x77
};

enum SystemValues
{
    SYSVAL_VERSION_STRING     = 0,
    SYSVAL_CURRENT_TIME       = 1,
    SYSVAL_DATA_PRESENT       = 2
};

#endif // __MARIO_QUERIES_HH__
```

Figure 10e